# DATA SHEET

# TDA3845; TDA3845T
## Quasi split-sound circuit and AM demodulator

Objective specification
File under Integrated Circuits, IC02

January 1993

Philips
Semiconductors

PHILIPS

## FEATURES

- Power supply from 5 V (200 mW) to 8 V source also an alternative 12 V source (12 V not for TDA3845T)
- Gain controlled wideband IF amplifier (AC coupled with three stages)
- High precision internal 90° phase shifter for quadrature demodulator
- Amplitude detector for gain control which operates as a peak detector for FM sound and as a mean level detector for AM sound (switchable)
- In-phase wideband synchronous demodulator for AM detection
- Stabilizer circuit for ripple rejection and constant output signals
- ESD protection for all pins
- Suitable for all FM standards and L as well as L-accent standard
- NICAM compatible.

## GENERAL DESCRIPTION

The TDA3845 is a quasi split-sound IF circuit which is designed to provide high performance television FM/AM sound.

## QUICK REFERENCE DATA

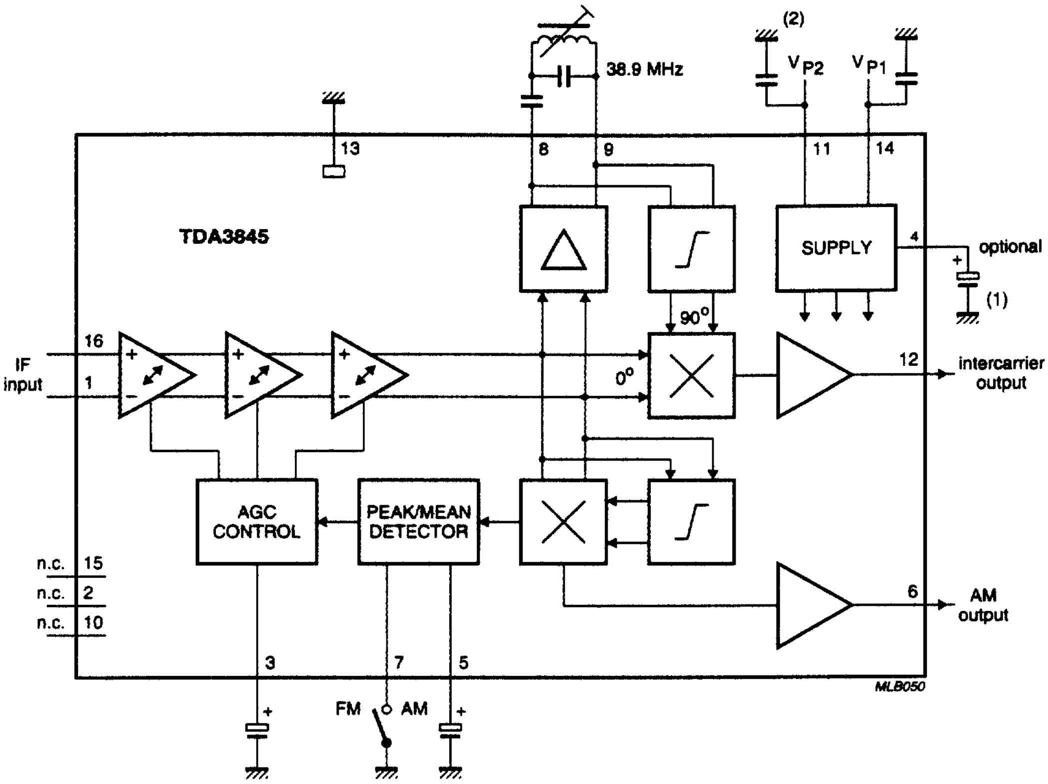
| SYMBOL | PARAMETER | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|
| | positive supply voltage | | | | |
| $V_{P1}$ | pin 14 | 4.5 | 5.0 | 8.8 | V |
| $V_{P2}$ | pin 11 (not for TDA3845T) | 10.8 | 12.0 | 13.2 | V |
| $I_P$ | supply current | – | 40 | – | mA |
| $V_{1\text{-}16(RMS)}$ | minimum IF input voltage (RMS value) | – | 70 | 100 | µV |
| | IF control range | 60 | 63 | – | dB |
| $V_{12\text{-}13(RMS)}$ | intercarrier output voltage 5.5 MHz (RMS value) | 70 | 100 | – | mV |
| (S +W)/W | signal-to-weighted-noise ratio (relative to 1 kHz; 50 kHz deviation) | | | | |
| | at 5.5 MHz for 2T/20T | – | 60 | – | dB |
| | at 5.742 MHz for 2T/20T | – | 58 | – | dB |
| $V_{6\text{-}13(RMS)}$ | AF output voltage AM (RMS value) | 440 | 550 | 660 | mV |
| (S +W)/W | signal-to-weighted-noise ratio; AM mode | – | 56 | – | dB |
| THD | total harmonic distortion; AM mode | – | 1 | 2 | % |
| $T_{amb}$ | operating ambient temperature | 0 | – | +70 | °C |

## ORDERING INFORMATION

| EXTENDED TYPE NUMBER | PACKAGE | | | |
|---|---|---|---|---|
| | PINS | PIN POSITION | MATERIAL | CODE |
| TDA3845 | 16 | DIL | plastic | SOT38[1] |
| TDA3845T | 16 | SO16 | plastic | SOT109A[2] |

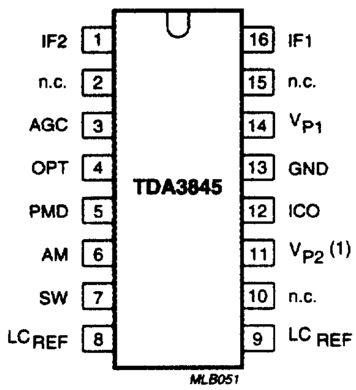
**Note**

1. SOT38-1; 1996 November 28.
2. SOT109-1; 1996 November 28.




(1) See note 10 to the characteristics.
(2) Not for TDA3845T, pin 11 not connected.

Fig.1 Block diagram.




(1) not for TDA3845T, pin 11 not connected.

Fig.2 Pin configuration.

## PINNING

| SYMBOL | PIN | DESCRIPTION |
|---|---|---|
| IF2 | 1 | IF amplifier input 2 |
| n.c. | 2 | not connected |
| AGC | 3 | AGC control capacitor |
| OPT | 4 | optional capacitor (see note 10 to the characteristics) |
| PMD | 5 | peak/mean detector capacitor |
| AM | 6 | AM output |
| SW | 7 | FM/AM switch |
| $LC_{REF}$ | 8 | LC reference circuit for the picture carrier |
| $LC_{REF}$ | 9 | LC reference circuit for the picture carrier |
| n.c. | 10 | not connected |
| $V_{P2}$ | 11 | positive supply voltage 2 (+12 V); note 1 |
| ICO | 12 | intercarrier output |
| GND | 13 | ground (0 V) |
| $V_{P1}$ | 14 | positive supply voltage 1 (+5 V) |
| n.c. | 15 | not connected |
| IF1 | 16 | IF amplifier input 1 |

**Note to Pinning**

1. Not for TDA3845T, pin 11 not connected.

## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC134)

| SYMBOL | PARAMETER | MIN. | MAX. | UNIT |
|---|---|---|---|---|
| | supply voltage | | | |
| $V_{P1}$ | pin 14 | 4.5 | 8.8 | V |
| $V_{P2}$ | pin 11 (not for TDA3845T) | 10.8 | 13.2 | V |
| $T_{amb}$ | operating ambient temperature | 0 | +70 | °C |
| $T_{stg}$ | storage temperature | –25 | +125 | °C |

## CHARACTERISTICS

$V_{P1}$ = 5 V (note 11); $T_{amb}$ = 25 °C; all measurements are referenced to ground (pin 13); unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Supply** | | | | | | |
| | supply voltage | | | | | |
| $V_{P1}$ | pin 14 | | 4.5 | 5.0 | 8.8 | V |
| $V_{P2}$ | pin 11 (not for TDA3845T) | | 10.8 | 12.0 | 13.2 | V |
| $I_{tot}$ | total supply current | | – | 40 | 48 | mA |
| **IF amplifier** | | | | | | |
| $R_{1-16}$ | input resistance | | – | 2 | – | kΩ |
| $C_{1-16}$ | input capacitance | | – | 2.5 | – | pF |
| $V_{1-16(RMS)}$ | minimum IF input voltage (RMS value) | note 1 | – | 70 | 100 | μV |
| $V_{1-16(RMS)}$ | maximum IF input voltage (RMS value) | note 2 | 70 | 100 | – | mV |
| ΔG | gain control range | | 60 | 63 | – | dB |
| $G_{v3-16}$ | gain control voltage range | | 1.5 | – | 3.0 | V |
| $B_{IF}$ | IF bandwidth | –3 dB | 50 | 70 | – | MHz |
| $V_{1-16}$ | DC potential | | – | 1.7 | – | V |
| **Intercarrier mode (FM mode; standard B/G) notes 3, 4 and 5** | | | | | | |
| Reference amplifier | | | | | | |
| $V_{8-9(p-p)}$ | picture carrier amplitude (peak-to-peak value) | | – | 270 | – | mV |
| $R_{8-9}$ | operating resistance | | – | 4 | – | kΩ |
| $V_{8-9}$ | DC potential | | – | 3.9 | – | V |
| Intercarrier mixer and output stage | | | | | | |
| $V_{12(RMS)}$ | output signal (RMS value) | | | | | |
| | at 5.5 MHz | | 70 | 100 | – | mV |
| | at 5.74 MHz | | 32 | 45 | – | mV |
| $B_{12}$ | intercarrier bandwidth | | | | | |
| | at –1 dB | | – | 8 | – | MHz |
| | at –3 dB | | – | 9 | – | MHz |
| | residual video AM on intercarrier signal | note 6 | – | 3 | 10 | % |
| $R_{12}$ | output resistance | | – | 30 | – | Ω |
| $V_{12}$ | DC potential | | – | 1.8 | – | V |
| $I_{12(peak)}$ | permissible AC output current (peak value) | note 7 | – | – | ±0.7 | mA |
| $I_{12}$ | permissible DC output current | | – | – | –2 | mA |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| AF signal performance (note 8) | | | | | | |
| (S +W)/W | black picture | | 60/58 | 68/64 | – | dB |
| (S +W)/W | 2T/20T pulses with white bars | | 57/55 | 60/58 | – | dB |
| (S +W)/W | 6 kHz sinewave (black-to-white modulation) | | 53/51 | 57/55 | – | dB |
| (S +W)/W | 250 kHz square wave (black-to-white modulation) | | 50/44 | 56/50 | – | dB |
| **AM mode (standard L) note 9** | | | | | | |
| S/N weighted in accordance with CCIR 468-3 | | | | | | |
| $V_{6(RMS)}$ | AF output signal (RMS value) | | 440 | 550 | 660 | mV |
| $B_{AF}$ | AF bandwidth | –3 dB; note 12 | 0.02 | – | 120 | kHz |
| THD | total harmonic distortion | | – | 1 | 2 | % |
| (S +W)/W | signal-to-weighted-noise ratio | note 10 | 50 | 56 | – | dB |
| $R_6$ | output resistance | | – | 200 | – | Ω |
| $V_6$ | DC potential | | – | 1.8 | – | V |
| $I_{6(peak)}$ | permissible AC output current (peak value) | note 7 | – | – | ±0.3 | mA |
| $I_6$ | permissible DC output current | | – | – | –1 | mA |
| **Standard switch (note 4)** | | | | | | |
| $V_7$ | peak signal AGC (FM mode) | $V_{P1}$ used | 1.8 | – | $V_{P1}$ | V |
| $V_7$ | or switch open-circuit | $V_{P2}$ used | 1.8 | – | 5.5 | V |
| $V_7$ | mean signal AGC (AM mode) | | – | – | 0.8 | V |
| $I_7$ | switch current | | | | | |
| | at 0 V | | – | – | –200 | μA |
| | at $V_{P1}$ | | – | – | 10 | μA |
| | at $V_{P2}$ | via a 2.2 kΩ series resistor | – | – | 2.5 | mA |
| **Ripple rejection (note 13)** | | | | | | |
| AM/AF signal | | | | | | |
| αRR | voltage ripple on $V_P$/ voltage ripple on output signal | | 30 | 40 | – | dB |
| FM phase noise | | | | | | |
| Δf(RMS) | intercarrier signal | | – | 10 | 20 | Hz |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **AM mode (standard L) note 9** | | | | | | |
| S/N weighted in accordance with CCIR 468-3 | | | | | | |
| $V_{6(RMS)}$ | AF output signal (RMS value) | | 440 | 550 | 660 | mV |
| $B_{AF}$ | AF bandwidth | –3 dB; note 12 | 0.02 | – | 120 | kHz |
| THD | total harmonic distortion | | – | 1 | 2 | % |
| (S +W)/W | signal-to-weighted-noise ratio | note 10 | 50 | 56 | – | dB |
| $R_6$ | output resistance | | – | 200 | – | Ω |
| $V_6$ | DC potential | | – | 1.8 | – | V |
| $I_{6(peak)}$ | permissible AC output current (peak value) | note 7 | – | – | ±0.3 | mA |
| $I_6$ | permissible DC output current | | – | – | –1 | mA |
| **Standard switch (note 4)** | | | | | | |
| $V_7$ | peak signal AGC (FM mode) | $V_{P1}$ used | 1.8 | – | $V_{P1}$ | V |
| $V_7$ | or switch open-circuit | $V_{P2}$ used | 1.8 | – | 5.5 | V |
| $V_7$ | mean signal AGC (AM mode) | | – | – | 0.8 | V |
| $I_7$ | switch current | | | | | |
| | at 0 V | | – | – | –200 | μA |
| | at $V_{P1}$ | | – | – | 10 | μA |
| | at $V_{P2}$ | via a 2.2 kΩ series resistor | – | – | 2.5 | mA |
| **Ripple rejection (note 13)** | | | | | | |
| AM/AF signal | | | | | | |
| αRR | voltage ripple on $V_P$/ voltage ripple on output signal | | 30 | 40 | – | dB |
| FM phase noise | | | | | | |
| Δf(RMS) | intercarrier signal | | – | 10 | 20 | Hz |

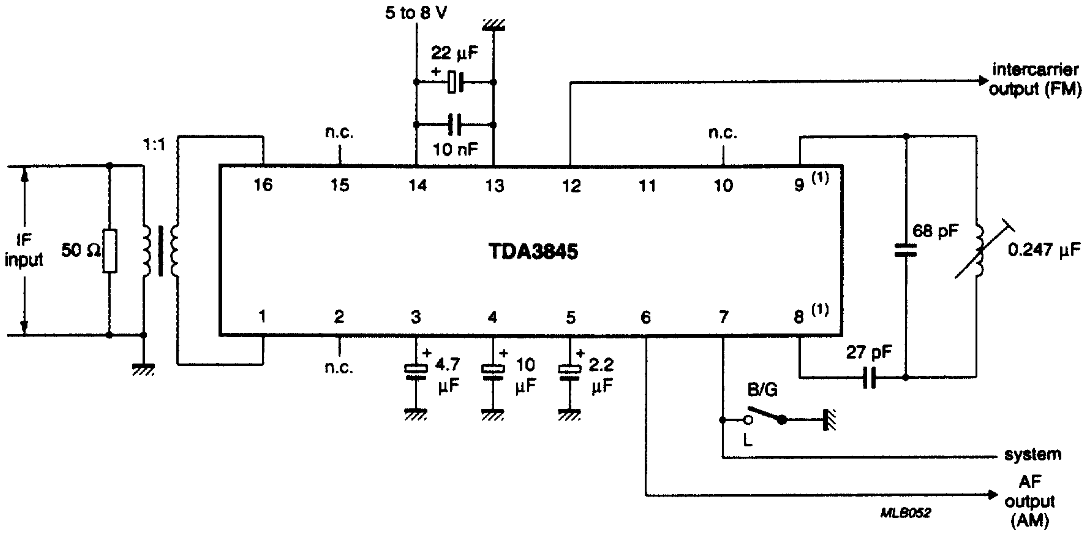
**Notes to the characteristics**

1. Start of gain control (LOW IF input signal) at –3 dB intercarrier signal reduction at pin 12, AGC mode set to FM or –3 dB AF signal reduction at pin 6, AGC mode set to AM.
2. End of gain control (HIGH IF input signal) at +1 dB intercarrier signal expansion at pin 12, AGC mode set to FM or +1 dB AF signal expansion at pin 6, AGC mode set to AM.
3. Picture carrier (38.9 MHz) to sound carriers (33.4 MHz/33.158 MHz) ratio: 13/20 dB.
   IF input signal (picture carrier at sync pulse); $V_{1-16}$ = 10 mV (RMS). Transmitter mode: DSB.
   Reference for the (S + W)/W ratio (0 dB) corresponds to the sound modulation where f = 1 kHz and frequency deviation $\Delta f = \pm$ 50 kHz.
   With reduced frequency deviation $\Delta f = \pm$ 27 kHz and the (S + W)/W figures will decrease by 5.4 dB.
4. If the device is used only for the B/G standard (no AM), the capacitor at pin 5 can be omitted (pin 5 has to be disconnected). In this event the AGC will always operate as a peak signal AGC and is independent of the voltage at pin 7.
   The AM mode can also be used for the B/G standard, consequently standard switching is not required. However, the intercarrier level depends on the video modulation and the AF performance may decrease.
   When the IC is operated from a 12 V power supply pin 7 can be connected to a 12 V logic level via a 2.2 kΩ resistor.
5. LC reference circuit for the picture carrier (pins 8 and 9); 68 pF/0.247 µH; in series with 27 pF:
   Q loaded = 40 (Qo = 90); tuned to 38.9 MHz yields quadrature demodulation for the picture carrier which provides optimum video suppression at the intercarrier output (e.g. black-to-white jump of the video modulation.The series capacitor provides a notch at the sound carrier frequency in order to produce more attenuation for the sound carrier in the PC reference channel. The ratio of parallel to series capacitance depends on the ratio of picture to sound carrier frequency which has to be adapted to other TV transmission standards, if required, in accordance with the formula:
   $C_S = C_P (f_{PC} / f_{SC})^2 - C_P$
   Where:
   $C_S$ = series capacitor
   C = parallel capacitor
   $f_{PC}$ = picture carrier frequency
   $f_{SC}$ = sound carrier frequency
   The result is an improved ‘intercarrier buzz’ in the stereo system B/G, particularly with 250 kHz video modulation (up to 10 dB improvement in sound Channel 2), or to suppress 350 kHz video modulated beat in the digitally modulated NICAM subcarrier
   In order to optimize the AF signal performance, fine tuning to the optimum S/W at the sound Channel 2 may be achieved by a 250 kHz video modulated square wave.
6. Residual video AM is defined as:
   m = (A–B)/A
   A = intercarrier level at sync pulse
   B = intercarrier level at 100% white video modulation
7. If higher AC output current is required an external resistor must be connected between the output pin and ground in order to increase the bias current of the emitter follower. The permissible maximum DC output current must not be exceeded.

8. For all S/N measurements the used vision IF modulator must conform to the following:

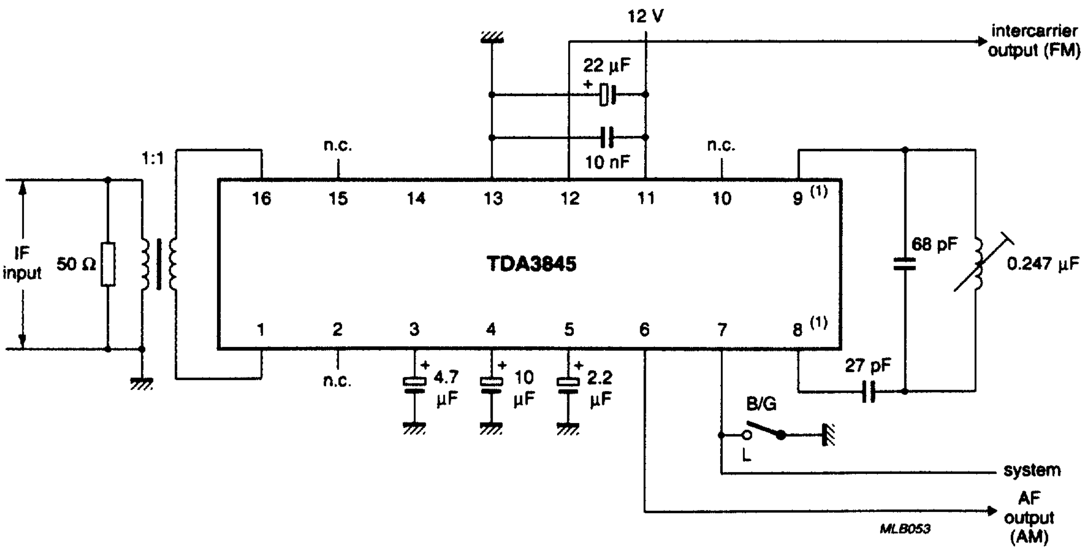
   Incidental phase modulation for black-to-white jump should be less than 0.5 degrees. Intercarrier performance, measured with the television demodulator AMF2 (intercarrier mode weighted S/N ratio) better than 60 dB for 6 kHz sinewave black-to-white video modulation. Weighted S/N ratio of the demodulated intercarrier signals in accordance with CCIR 468-3, measured with de-emphasis of 50 µs.

   The indicated (S + W)/W ratio X/Y concerns the sound channels 1 and 2 that means demodulated intercarrier signals of 5.5 and 5.74 MHz respectively.
9. Sound carrier frequency in the range of 30 to 40 MHz modulated with f = 1 kHz and a modulation depth of 80%. IF input signal (sound carrier) $V_{1\text{-}16}$ = 10 mV (RMS).
10. The capacitor at pin 4 can be omitted, however, the (S + W)/W figure for the AM sound (standard L) will be up to 8 dB worse in the IF voltage range 1 mV to 100 mV.
11. When the supply at $V_{P2}$ = 12 V the performance will be comparable with the performance when $V_{P1}$ = 5 to 8 V. The power supply pin that is not in use should be disconnected.
12. The maximum value given as minimum 120 kHz and typical 700 kHz.
13. Voltage ripple $<$ 200 mV (p-p) at 70 Hz.




(1) See note 5 to the characteristics.

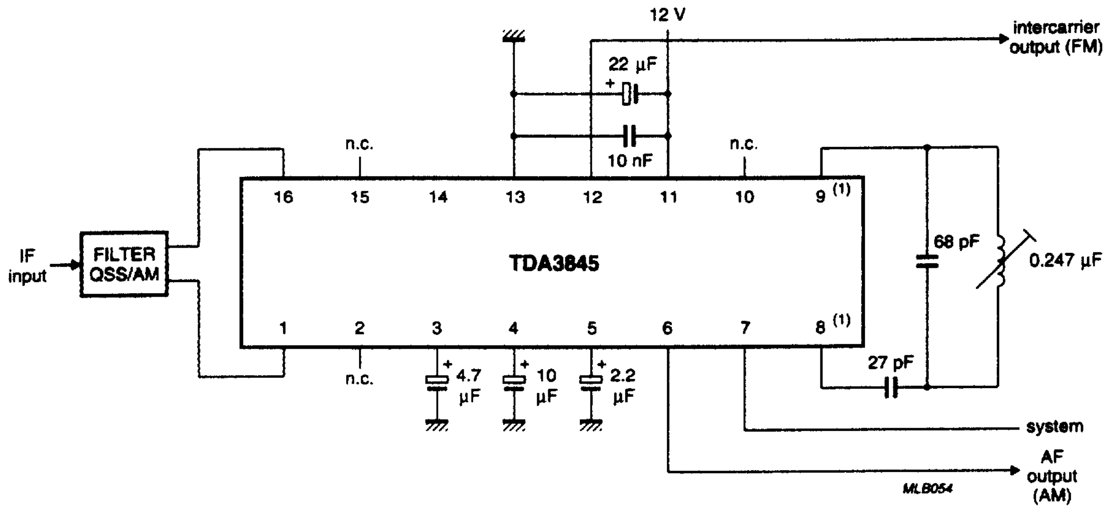
Fig.3 Test circuit for the +5 V supply.




(1) See note 5 to the characteristics.

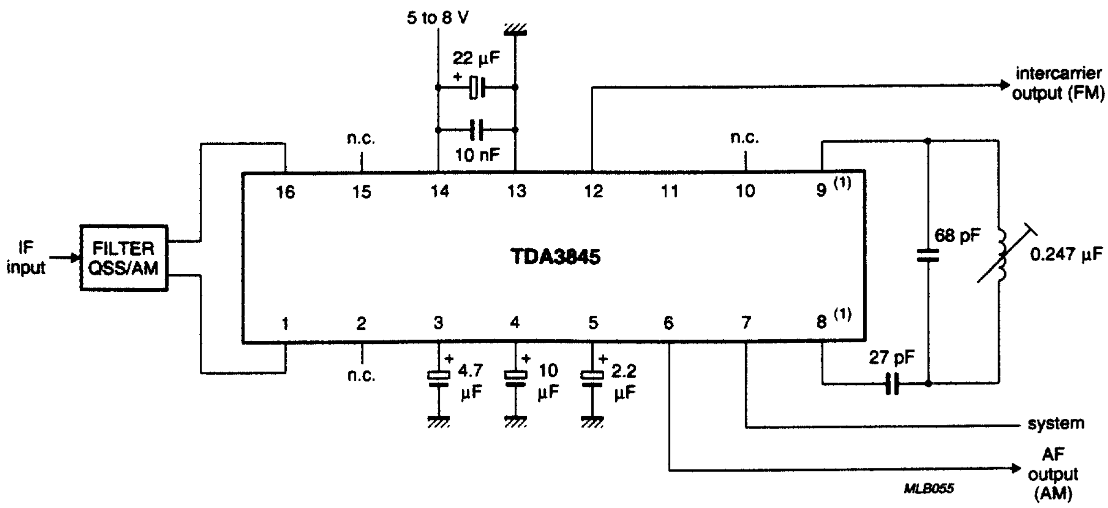
Fig.4 Test circuit for the +12 V supply; not for TDA3845T.

## APPLICATION INFORMATION




(1) See note 5 to the characteristics.

Fig.5 Application diagram for the +12 V supply; not for TDA3845T.




(1) See note 5 to the characteristics.

Fig.6 Application diagram for the +5 V supply.

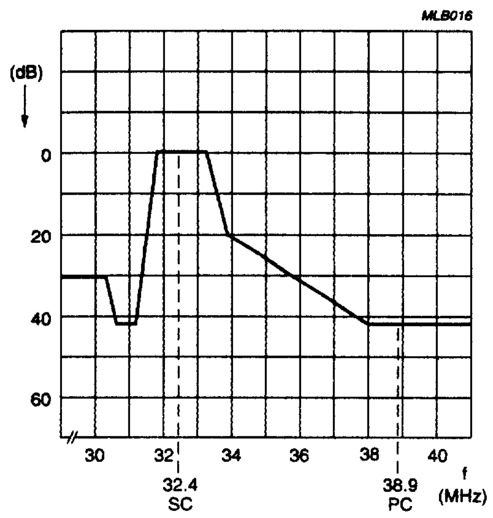



Fig.7 AM IF filter for standard L.

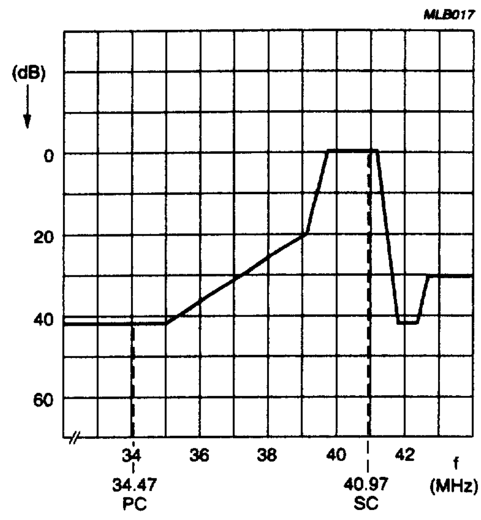



Fig.8 AM IF filter for standard L-accent.

**IF filter proposal for AM sound (see Figs 7 and 8)**

With an IF filter in accordance with this proposal, the video buzz suppression on the audio output is better than 50 dB (in accordance with CCIR 468-3, m = 54%) for the worst case video modulation with 6 kHz sinewave black-to-white.

**Note to figures 7 and 8.**

Where SC = sound carrier and PC = picture carrier.

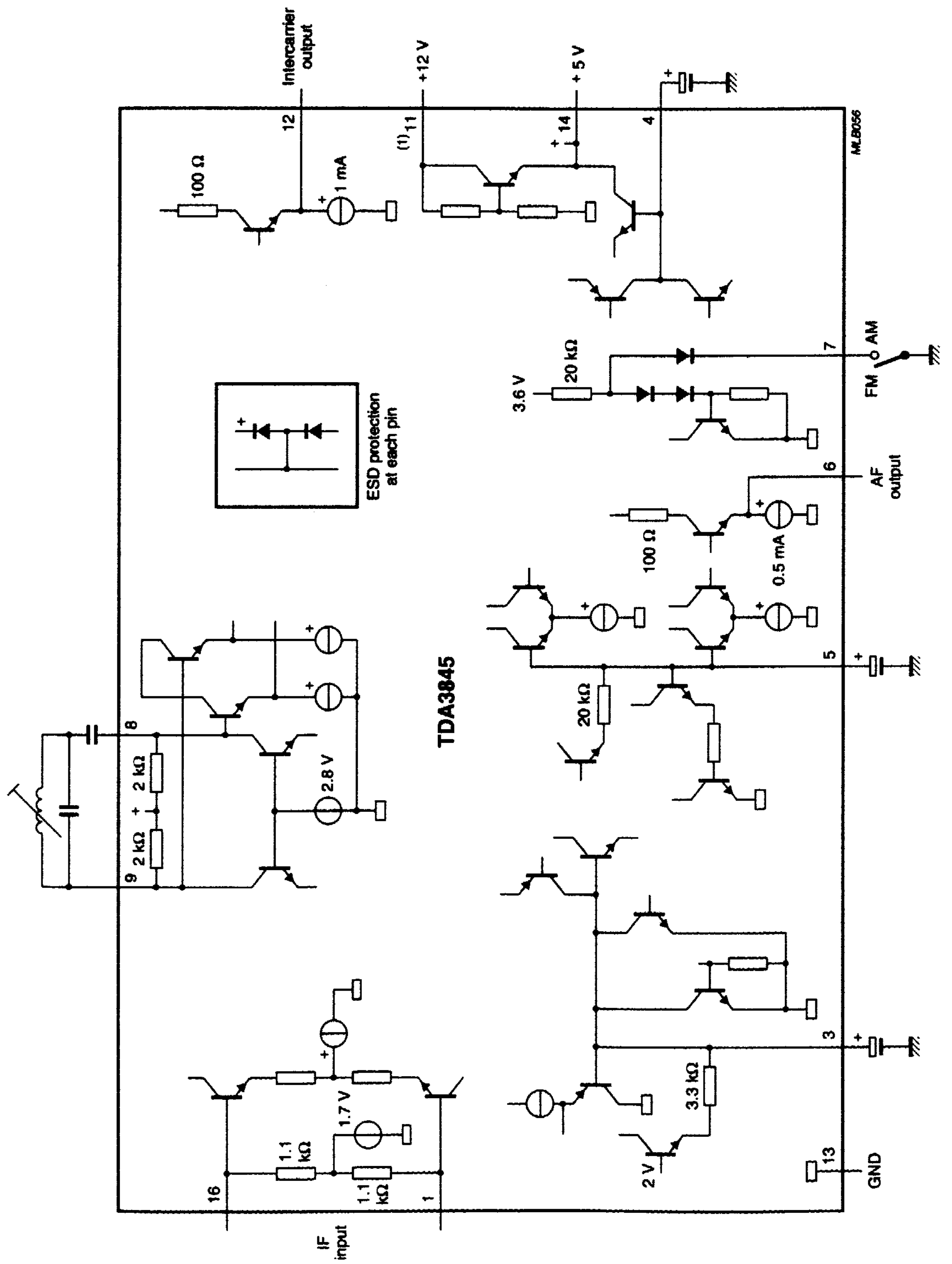
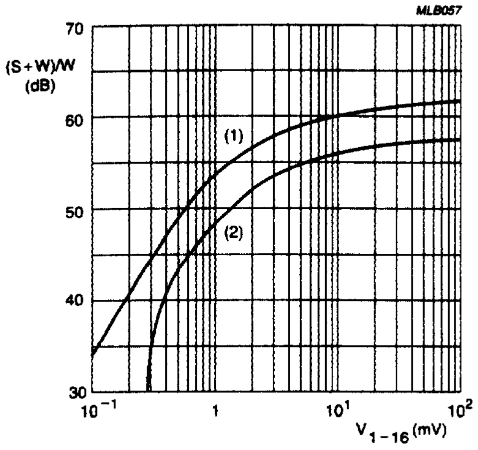



Fig.9 Internal pin circuitry.

(1) Not for TDA3845T; pin 11 not connected.




Picture modulation; 6 kHz sinewave.

Intercarrier signal; sound Channel 1 = 5.5 MHz,
sound Channel 2 = 5.74 MHz.

Fig.10 Response curve of the signal-to-weighted noise ratio of the demodulated intercarrier signal.

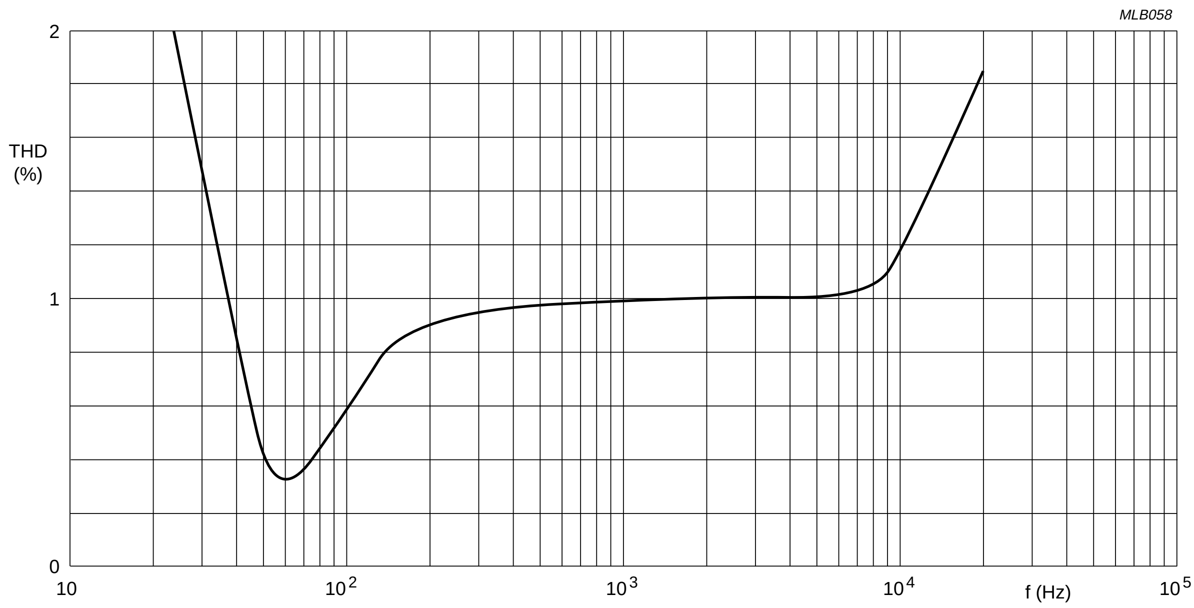
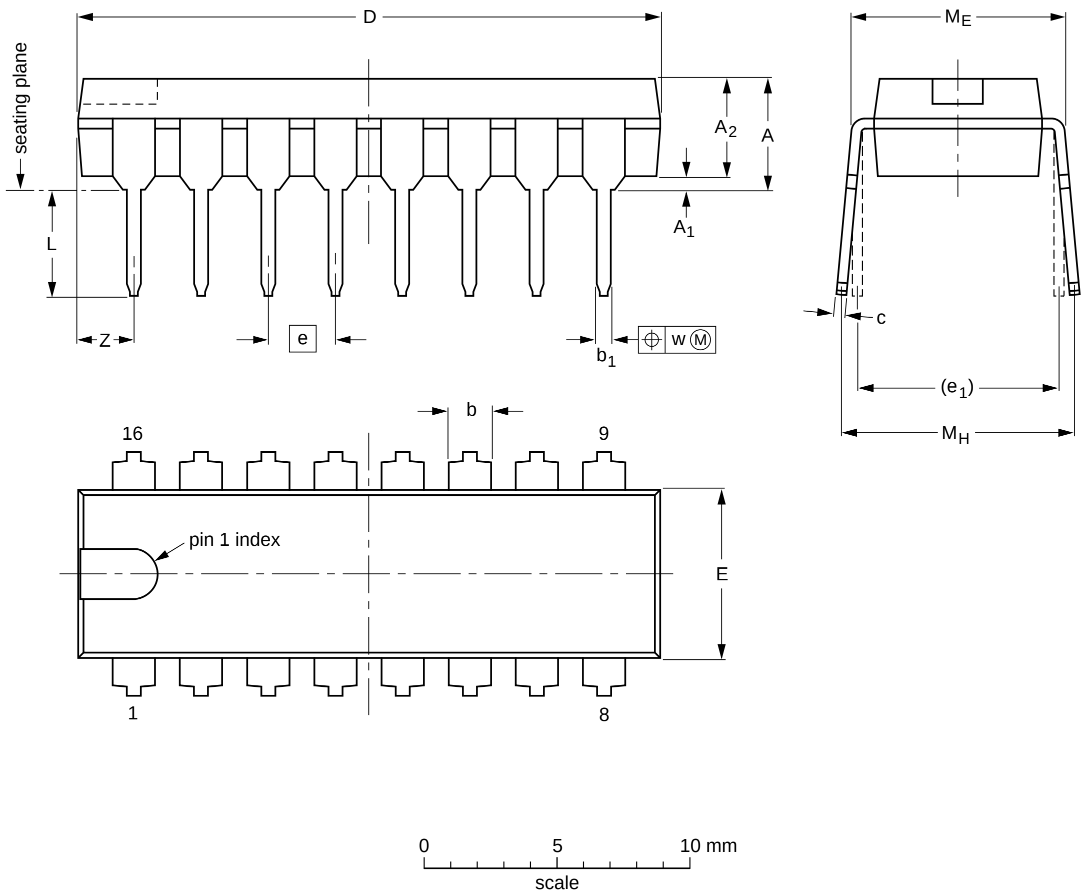



Fig.11 Response curve for the total harmonic distortion of the AM signal.

## PACKAGE OUTLINES

**DIP16: plastic dual in-line package; 16 leads (300 mil); long body** **SOT38-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

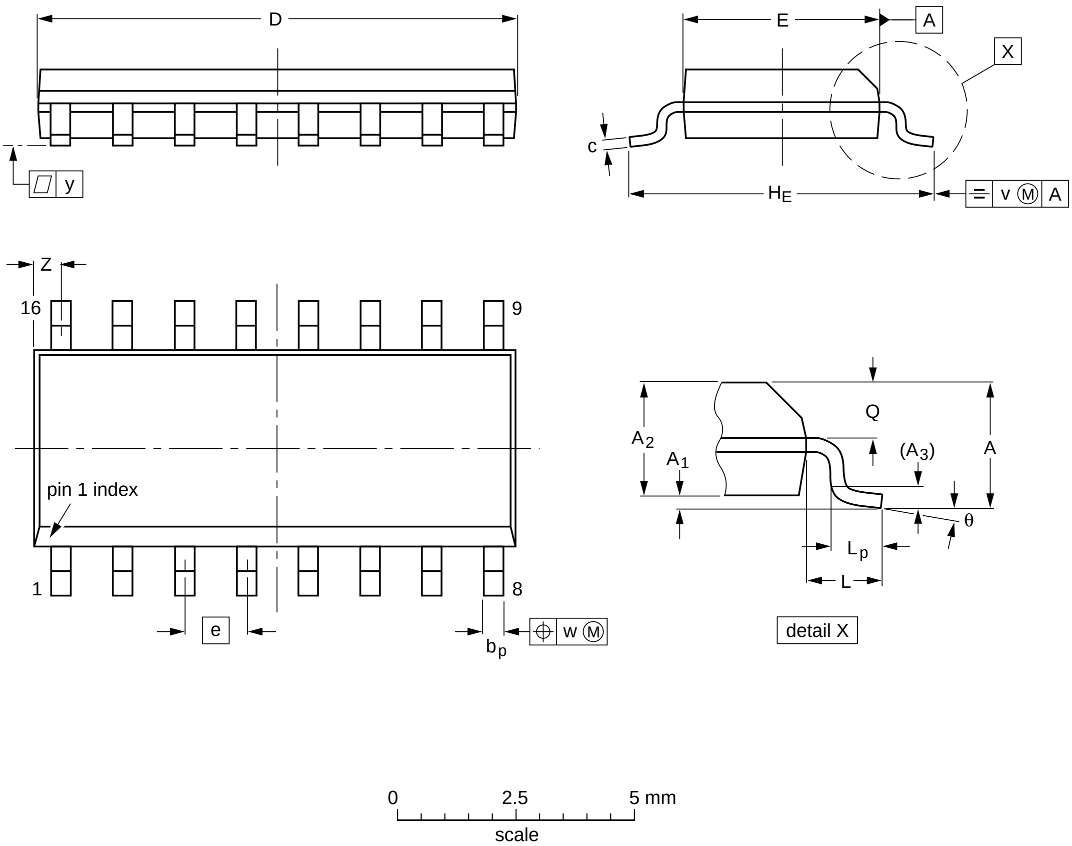
| UNIT | A max. | $A_1$ min. | $A_2$ max. | b | $b_1$ | c | D (1) | E (1) | e | $e_1$ | L | $M_E$ | $M_H$ | w | Z (1) max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.7 | 0.51 | 3.7 | 1.40<br>1.14 | 0.53<br>0.38 | 0.32<br>0.23 | 21.8<br>21.4 | 6.48<br>6.20 | 2.54 | 7.62 | 3.9<br>3.4 | 8.25<br>7.80 | 9.5<br>8.3 | 0.254 | 2.2 |
| inches | 0.19 | 0.020 | 0.15 | 0.055<br>0.045 | 0.021<br>0.015 | 0.013<br>0.009 | 0.86<br>0.84 | 0.26<br>0.24 | 0.10 | 0.30 | 0.15<br>0.13 | 0.32<br>0.31 | 0.37<br>0.33 | 0.01 | 0.087 |

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT38-1 | 050G09 | MO-001AE | | | | ~~92-10-02~~<br>95-01-19 |

**SO16: plastic small outline package; 16 leads; body width 3.9 mm** **SOT109-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.75 | 0.25<br>0.10 | 1.45<br>1.25 | 0.25 | 0.49<br>0.36 | 0.25<br>0.19 | 10.0<br>9.8 | 4.0<br>3.8 | 1.27 | 6.2<br>5.8 | 1.05 | 1.0<br>0.4 | 0.7<br>0.6 | 0.25 | 0.25 | 0.1 | 0.7<br>0.3 | 8°<br>0° |
| inches | 0.069 | 0.0098<br>0.0039 | 0.057<br>0.049 | 0.01 | 0.019<br>0.014 | 0.0098<br>0.0075 | 0.39<br>0.38 | 0.16<br>0.15 | 0.050 | 0.24<br>0.23 | 0.041 | 0.039<br>0.016 | 0.028<br>0.020 | 0.01 | 0.01 | 0.004 | 0.028<br>0.012 | |

**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT109-1 | 076E07S | MS-012AC | | | | ~~91-08-13~~<br>95-01-23 |

## SOLDERING

### Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

### DIP

SOLDERING BY DIPPING OR BY WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

REPAIRING SOLDERED JOINTS

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

### SO

REFLOW SOLDERING

Reflow soldering techniques are suitable for all SO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

WAVE SOLDERING

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

REPAIRING SOLDERED JOINTS

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

# Quasi split-sound circuit and AM demodulator

# TDA3845; TDA3845T

## DEFINITIONS

| **Data sheet status** | |
|---|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| **Limiting values** | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| **Application information** | |
| Where application information is given, it is advisory and does not form part of the specification. | |

## LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.